

**DESIGN & ANALYSIS OF ALGORITHMS
(INFO 2203)**

Time Allotted : 3 hrs

Full Marks : 70

Figures out of the right margin indicate full marks.

*Candidates are required to answer Group A and
any 5 (five) from Group B to E, taking at least one from each group.*

Candidates are required to give answer in their own words as far as practicable.

**Group – A
(Multiple Choice Type Questions)**

1. Choose the correct alternative for the following: **10 × 1 = 10**
- (i) Which of the following sorting algorithms is used along with quick sort to sort the sub arrays?
(a) Merge sort (b) Shell sort (c) Insertion sort (d) Bubble sort.
- (ii) Which of the following condition is sufficient to detect cycle in a directed graph?
(a) There is an edge from currently being visited node to an already visited node
(b) There is an edge from currently being visited node to an ancestor of currently visited node in DFS forest
(c) Every node is seen twice in DFS
(d) None of the above.
- (iii) Master's theorem is used for?
(a) Solving recurrences (b) Solving iterative relations
(c) Analysing loops (d) Calculating the time complexity of any code.
- (iv) Match the following:
- | Group A | Group B |
|---|------------------------|
| a) Dijkstra's single shortest path algo | p) Dynamic Programming |
| b) Bellmen Ford's single shortest path algo | q) Backtracking |
| c) Floyd Warshell's all pair shortest path algo. | r) Greedy Algorithm |
| (a) a-r, b-q, c-p (b) a-p, b-p, c-p (c) a-r, b-p, c-p (d) a-p, b-r, c-q. | |
- (v) Which is the safest method to choose a pivot element in quick sort?
(a) Choosing a random element as pivot
(b) Choosing the first element as pivot
(c) Choosing the last element as pivot
(d) Median-of-three partitioning method.
- (vi) If these are n elements in the heap inserting a new element takes __ time in the work case.
(a) $O(\log n)$ (b) $(\log n)$ (c) $\Omega(\log n)$ (d) $\Omega(n)$

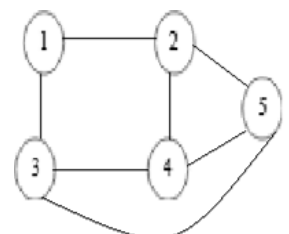
- (vii) Which type of best first search algorithm was used to predict the closeness of the end of path and its solution?
(a) Greedy BFS (b) Divide and Conquer
(c) Heuristic BFS (d) Combinatorial.
- (viii) Which of the following is false about Prim's algorithm?
(a) It is a greedy algorithm
(b) It constructs MST by selecting edges in increasing order of their weights
(c) It never accepts cycles in the MST
(d) It can be implemented using the Fibonacci heap.
- (ix) Let S be an NP-complete problem and Q and R be two other problems not known to be in NP. Q is polynomial time reducible to S and S is polynomial-time reducible to R. Which one of the following statements is true?
(a) R is NP-complete (b) R is NP-hard
(c) Q is NP-complete (d) Q is NP-hard.
- (x) What is the objective of the knapsack problem?
(a) To Get Maximum Weight In The Knapsack
(b) To Get Minimum Total Value In The Knapsack
(c) To Get Maximum Total Value In The Knapsack
(d) To Get Minimum Weight In The Knapsack.

Group - B

2. (a) Compare big Oh and small oh notation. Show that $10n^2 + 9 \approx O(n)$ is incorrect.
[[CO1](Analyze/IOCQ)(Evaluate/HOCQ)]
- (b) Applying divide and conquer method, step wise sort the following set of unsorted elements using \ quick sort algorithm.
130 102 211 601 621 115 75 122
Also deduce the average case time complexity of the quick sort algorithm.
[CO2(Analyze/Analyze/IOCQ/IOCQ)]
 $(2 + 2) + (5 + 3) = 12$
3. (a) State master's theorem and deduce the time complexity for the following recurrences using master theorem:
(i) $T(n) = 4T(n/3) + \log n$
(ii) $T(n) = 7T(n/3) + n^2$ [[CO1,CO4](Evaluate/HOCQ)]
- (b) Compare Strassen's Matrix multiplication method with conventional matrix multiplication method.
[[CO1,CO4](Evaluate/HOCQ)]
 $(3 + 3 + 3) + 3 = 12$

Group - C

4. (a) Using the backtracking method write an algorithm for m-coloring problem. By considering the following graph show all possible solutions of m-coloring using a state space tree.
[[CO2,CO3](Understand/LOCQ)]



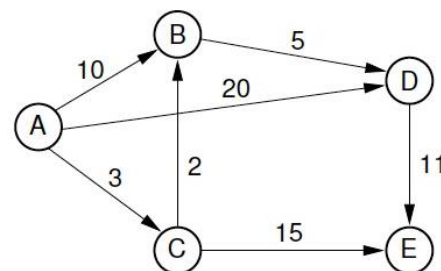
- (b) Write an algorithm of best first search.

[[CO3](Understand/LOCQ)]

$$(5 + 3) + 4 = 12$$

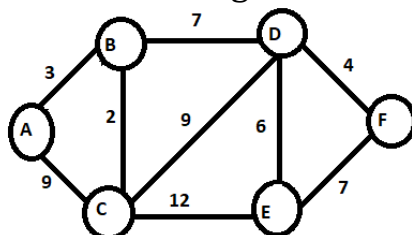
5. (a) Write the Max-Flow Min-Cut theorem. Consider the following flow graph and find out the maximum flow using Ford-Fulkerson algorithm where source node is A and sink node is E.

[[CO3](Understand/LOCQ)]



- (b) Find out the shortest path of the following graph using Bidirectional search where source node is A and target node is F.

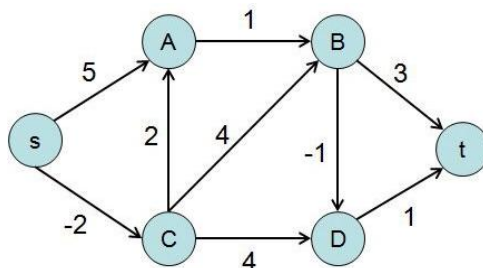
[[CO3](Understand/LOCQ)]



$$(2 + 6) + 4 = 12$$

Group - D

6. (a) Consider the following graph and apply Bellman-Ford's algorithm to find out the shortest-path from source vertex s. Find the complexity of the said algorithm.



[[CO2,CO3](Understand/LOCQ)]

- (b) Why Dijkstra's algorithm fail on negative weight? Compare the Dijkstra's algorithm with Bellman-Ford's algorithm.

[[CO2,CO3](Analyze/IOCQ)]

$$(6 + 2) + (2 + 2) = 12$$

7. (a) Find an optimal parenthesization of a matrix-chain product whose sequence of dimensions is {15, 10, 20, 35, 25, 30} also show the number of multiplication of different length of matrices. Also comment about the space requirement of the above process.

[[CO2,CO3](Understand/LOCQ)]

- (b) Compare between greedy method and dynamic programming.

[[CO2,CO3](Understand/LOCQ)](Analyze/IOCQ)]

- (c) Comment on the applicability of Dijkstra's shortest path algorithm to the TSP problem.

[[CO2,CO3](Understand/LOCQ)](Analyze/IOCQ)]

$$(6 + 2) + 2 + 2 = 12$$

Group - E

8. (a) Show that 2SAT is in P but 3SAT is NP-complete.

[[CO5](Analyze/IOCQ)]

- (b) Write a non-deterministic algorithm of clique decision problem.

[[CO5](Analyze/IOCQ)]

- (c) What is Polynomial Reduction? [[C05](Understand/LOCQ)]
 (d) Discuss diagrammatically the relations among P class, NP class, NP hard and NP complete. [[C05](Understand/LOCQ)]
4 + 4 + 2 + 2 = 12

9. (a) Describe approximate algorithm for TSP & calculate its performance ratio. [[C06](Evaluate/HOCQ)]
 (b) Explain Branch and Bound method to solve 15 puzzle problem. [[C02](Understand/LOCQ)]
(6 + 2) + 4 = 12
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<i>Cognition Level</i>	<i>LOCQ</i>	<i>IOCQ</i>	<i>HOCQ</i>
<i>Percentage distribution</i>	<i>50</i>	<i>25</i>	<i>25</i>

Course Outcome (CO):

After the completion of the course students will be able to

1. Demonstrate how the time complexity of an algorithm is defined and analyze the asymptotic performance of algorithms.
2. Understand basic algorithm designing techniques such as divide and conquer, greedy, dynamic programming, branch and bound, backtracking and analyze them.
3. Explain the graph algorithms such as BFS, DFS, Ford Fulkerson Method, etc and analyze them.
4. Synthesize efficient algorithms in common engineering design situations.
5. Exploration of various research problems in algorithm like NP-hard and NP-complete problems.
6. Explain what an approximation algorithm is, and the benefit of using approximation algorithms.

**LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question.*